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ABSTRACT

This ERIC Digest discusses science notebooks and how they can be used as a tool for increasing achievement not only in science but across the curriculum. The use of science notebooks allows students to become actively involved in their own learning and affords them the opportunity to investigate content in which they are naturally interested and wrestle with authentic problems. Using science notebooks to implement appropriate assessment practices is also discussed. (Author/NB)

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Science Notebooks: Tools For Increasing Achievement Across the Curriculum

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DIGEST
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Clearinghouse for Science, Mathematics, and Environmental Education

With the implementation of high stakes accountability programs, instruction in science has suffered. In some states, science is receiving decreased attention because it is not tested. A 1999 study of elementary school teachers found that 34 percent of instructional time was being devoted to reading, 24 percent to mathematics, and 17 percent to writing, while only 9 percent of total class time was spent on social studies, and only 8 percent on science. Only physical education and health received less time than science at a mere 5 percent and 3 percent respectively (Jones, et al., 1999). This study was conducted in North Carolina where high-stakes testing had been implemented.

Other researchers have drawn similar conclusions. Smith (1991) discovered that instructional practices changed dramatically as the time to take the test grew closer. At the beginning of the school year, some teachers were involved in teaching hands-on science several days a week. By the end of the school year, science was not taught at all in some classrooms, and materials like tadpoles and fish tanks were being used for entertainment instead of exploration. In the classrooms where science was taught, science instruction during the weeks before the test was specifically tailored to the test. Social studies and health were not taught at all.

Obviously, this practice of reducing instructional time in science has serious implications. What is ironic, however, is that while some teachers are reducing the amount of time spent in science to make way for tested subjects, teachers who are implementing an active science program are showing startling results with student achievement across the curriculum. In El Centro, California, for example, teachers who implemented Science Notebooks, an inquiry science program, made impressive gains on standardized tests in science, reading, writing and mathematics. Having experienced the active science program for four years, fourth graders in the El Centro School District more than doubled their scores in science and reading and almost doubled scores in mathematics. Even more astonishing, after experiencing the program for four years, sixth graders' writing scores almost quadrupled (Klentschy, Garrison & Amaral, 1999).

Because of the present climate of high stakes accountability and *No Child Left Behind*, programs that promote achievement in multiple areas of the curriculum should not be ignored. This digest will describe what a science notebook is and how it can be used to influence achievement across the curriculum.

What are Science Notebooks?

Shavelson (2001, p. 2) defines a science notebook as "a compilation of entries that provide a partial record of the instructional experiences a student had in her or his classroom for a certain period of time". Not only do Science Notebooks provide information about classroom experiences, they imitate the journals that actual scientists use as they explore the world. Through writing in Science Notebooks, students engage in authentic scientific thinking as they carry out their own investigations. Science Notebooks include a question to explore, predictions, a description of what was done, and what students learned. In addition they may incorporate narrative statements and drawings about the student's observations, data sets, diagrams, graphs and tables.

Science Notebooks and journals are terms that are often used interchangeably. Although they do share some common characteristics (e.g., both include questions and are creative), they also differ in their format. Science Notebooks focus on the more structured type of writing that accompanies the scientific method and the use of science process skills whereas journals emphasize a more free-form type of writing that often expresses feelings and is found in literature reflection, fiction and poetry. Therefore, while it is important for students to learn how to use both types of writings, Science Notebooks and journals should be distinguished from each other and maintained separately.

Assessing Science Achievement

The National Science Teachers Association recognizes the value in implementing appropriate assessment practices. In their 2002 position statement on elementary school science, they state that "assessment must be an essential component of an elementary science program." To this end, assessment must be aligned with a) what is of value, i.e., the problem-solving process, application of concepts, inquiry and process skills, b) the curricular objectives and c) the purpose for which it was intended: grading, diagnosis, student and/or parent feedback, etc. It is clear that Science Notebooks are viable tools for accomplishing the expectations described by NSTA.

While standardized tests provide information about what students know and can do at the end of instruction (usually at the end of the school year), there is an immediate need to regularly monitor student progress so as to influence best instructional practices. Science Notebooks provide this form of rich assessment data. Not only do students learn about themselves as scientists, teachers are informed about what and how students learn, and the efficacy of their instructional practices. These kinds of data enable the teacher to tailor instruction to what students really need.

This ongoing collection of data has become known as formative assessment. Formative assessment is assessment done within instruction as opposed to summative assessment (e.g., testing) that comes at the end of instruction. Unlike summative assessment, formative assessment happens early in the instructional process so that information gleaned from the assessment process can be used to inform instructional decisions. Formative assessment serves as a diagnostic tool to identify student strengths and weaknesses so a teacher

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can determine important next steps. Science Notebooks expose students' thinking and provide the teacher with important insights about student understandings. There is increasing evidence that formative assessment is particularly helpful for low achievers, thereby reducing the gap and increasing achievement overall (Black & Wiliam, 1998).

Using the Science Notebook to Assess Achievement Across the Curriculum

It is not surprising that Science Notebooks have a positive impact on writing achievement, if only because writing time is increased when Science Notebooks are employed. While these gains can be attributed in part to increased practice, much of the progress has to do with the type of writing in which students are engaged. Science Notebooks are based on a model for reflective writing developed through second-hand investigation texts (Magnusson & Palincsar, 2003). These texts include a "think aloud" feature that is common to the notebooks of actual scientists as they explore the world in a first hand manner. Using the second-hand investigations as a model has the potential of providing practice and guidance for students in writing excellent notebook entries as they carry out and write about their own investigations. This "think aloud" approach also boosts progress in mathematics as students record their thinking about how they solve problems in science. Engaging in authentic tasks allows students to connect to their work, making it easier to collaborate with other "scientists" in the class to compare hypotheses and conclusions. Whether this collaboration is done by reading other students notebooks or by discussing scientific phenomena in small groups, communication is clearly enhanced.

Drawing upon Magnusson and Palincsar's work, the Caltech Pre-College Science Initiative (CAPSI) has been involved in developing a model and guidelines for teachers for using Science Notebooks by investigating intermediate grade teachers' and students' use of Science Notebooks and its impact on student learning (Aschbacher & Baker, 2003). Their preliminary findings reveal a slight trend: students in classes who did conceptual writing (writing that included claims and evidence statements) did better on the post-test than students who did not do conceptual writing. Nesbit, Hargrove, Harrelson, and Maxey (2003) are studying what teachers do to engage primary age students in scientific thinking and how that affects what students write in their Science Notebooks.

While there is a need to conduct additional research on this topic, the following characteristics seem to make the implementation of an active science program using Science Notebooks a viable way to collect assessment data from multiple areas of the curriculum:

- Most of the work done in the notebook is descriptive or narrative. The qualitative nature of the notebook provides the teacher with insightful information about what students truly understand.
- The notebook is centered around authentic tasks such as collaborating, researching, analyzing and evaluating.
- The work done in the notebook is purposeful. Students are investigating their own questions in which they are genuinely interested.
- There is seldom one right answer or conclusion. In fact, it is not uncommon for the teacher to "discover" alongside the student.
- Other stakeholders are involved, primarily the student. Assessment of the science notebook is used to provide insight to students about how they learn and to inform the teacher of what the student needs next. Notebooks also serve as an excellent resource to demonstrate growth to parents - growth not only in science, but in multiple areas of the curriculum.

With the implementation of Science Notebooks, students become actively involved in their own learning. Students are afforded the opportunity to investigate content in which they are naturally interested and to wrestle with authentic problems. It only makes sense that achievement is enhanced in all areas of the curriculum.

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